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Director's Column

Setting Seasons

At the March meeting of the commission, the tentative opening dates and boundaries were made final by the commission. The commission reviewed the comments of sportsmen, landowner groups, and federal agencies.

With this consideration, the final dates were set. This method of sending out "tenatives" for review has proven most satisfactory and has been one of the major efforts of the commission to make contact with the sporting public and the landowner in the setting of seasons.

The moose, sheep, goats, and antelope special seasons were set in a tentative form so that the special seasons map can go to print and will be available for hunters to determine their choice of areas for special license applications. The final and exact quotas will be set in August as by that time many of the antelope areas have been flown and we will have more knowledge and understanding of the exact numbers that should be harvested.

At the April meeting, the commission will set the tentative closing dates and bag limits. Remember these will be mailed out to clubs and groups so the commission may have the benefit of your feelings as well as those of the department.

I know that all of us—department people, sportsmen and landowner groups—keep foremost in our minds that seasons must be set with good information, always thinking of what's best for Montana's natural resources and how we can enjoy the most hunting and still not cause problems for other land uses.

Montana residents who wish to receive "Montana Outdoors" are advised to mail their requests to the Information-Education Division, Montana Fish and Game Department, Helena, Montana 59601.

Please don't forget to include the zip code in your address.

WE'RE LEARNING ABOUT PADDLEFISH

The Yellowstone River, long noted for excellent trout fishing in its headwaters is fast becoming known for its paddlefish. Snagging of "paddlers" in the Yellowstone first started during the summer of 1962 at Intake, some 20 miles downstream from Glendive. Although fossil records show that paddlefish have been in Montana for approximately 60 million years, they have never been important to Montana fishermen until recently.

The increased paddlefish fishing pressure and interest in this species required that the Fish and Game Department learn the details behind this interesting fishery. A number of questions needed to be answered before this species could be wisely managed. Sportsmen and fishery biologists alike wondered why the paddlefish appeared so suddenly and in such great numbers in 1962, when very few had been reported before this. Where did the fish come from, and should there be a limit set on the number of fish taken by fishermen? In addition to these questions many other facts about the life history of the fish needed to be learned before sound recommendations as to seasons and limits could be made.

Information regarding paddlefish is relatively scarce considering that this fish has been around for so many years. Most of the information we do have regarding life history comes from other states. We do know that paddlefish are native to the Mississippi drainage and that they were taken commercially by fishermen of the central United States in the early 1900's. In 1915 roe from the ripening females was bringing $2.00 a pound and the flesh about ten cents a pound.

Fishery workers in Missouri have been studying the paddlefish for several years. They have found that paddlefish spawn over large gravel bars. After the eggs are fertilized they become adhesive and adhere to the first object they touch. The most favorable location for hatching of these eggs is clean gravel bars. Depending on the size, a female paddlefish will lay from 80,000 to 600,000 eggs.

This twenty-pound paddlefish was taken at Intake, near Glendive, Montana.

A study designed to answer some of the questions regarding paddlefish in Montana was initiated in May of 1964. The study was designed to answer specific questions about the movement, life history and the number of paddlefish caught by fishermen. A portion of this study has just been completed and the results have given us some insight about the paddlefish and its future management in Montana.

In any study to determine movement of fish, a large number of individuals need to be marked. During 1964 and 1965 a total of 1,146 paddlefish were tagged. The majority of these were marked with a plastic band inserted in their lower jaws and then released to the river in the Intake area.

Paddlefish are taken from the latter part of April through June. The runs may be correlated with water temperatures. Fishermen recaptured at least 164 of these tagged fish during the 1964 and 1965 seasons. Some of them were re-caught several times. The majority of the recaptured fish were caught in the same area where they were tagged, but six fish tagged in 1964 were caught in other areas. Four of these were recaptured in Garrison Reservoir, approximately 200 miles below the tagging site. One tagged fish was recaptured at the mouth of the Tongue River approximately 100 miles upstream from the tagging site. The fish that travelled the greatest distance was recaptured in the dredge cuts just below Fort Peck Reservoir. This fish travelled 70 miles down the Yellowstone River and then 190 miles up the Missouri River to Fort Peck.

Returns of tagged fish show that they move considerable distances both up and down stream, and that Garrison Reservoir may be the source of the fish caught in the Yellowstone River. Additional information on the age of paddlefish helps to substantiate that the fish may be moving up the Yellowstone River from Garrison Reservoir. Not enough information has been collected yet to say for certain that the paddler run originates in Garrison Resorvoir, but tagging data indicates that this is what is happening. Additional tagging information in the years to come should help prove or disprove this theory.

During 1964 and 1965 creel census information was collected at Intake in an attempt to determine the number of fish caught in this area. While this information was not completed on each fisherman, it is felt that it afforded a good estimate on the minimum number of fish caught. During 1964 the catch of paddlefish was estimated to be 5,900 fish weighing 65 tons. Fishermen kept 28 tons and returned the rest to the river. In 1965 the catch was estimated at 2,200 fish weighing 25 tons. Of these, 12 ton were kept by fishermen and the rest released. The weight of individual fish averaged about 22 pounds during both years. During both years female fish made up less than three percent of the fish caught.

The age structure of the paddlefish population being harvested at Intake was another part of this study. Paddlefish lay down annual growth rings in their cartilage similar to the growth rings of a tree. Unlike the boney skeleton of trout or pike, paddlefish have an internal skeleton composed primarily of cartilage. The lower jaws from a number of paddlefish were collected from fishermen in order to make the aging study. A small cross section was taken from each jaw and the annual rings counted. Using this method it was possible to get a good idea of the age of the paddlefish being caught.

The age of the fish ranged from four to 25 years with the majority seven to 12 years old. Paddlefish in this group comprised 88 percent of the total fish. Paddlefish older than 12 years and younger than seven years were rare. This population of fish, when compared to the paddlefish populations sampled in the Missouri River above Fort Peck, is much younger. In the Missouri River 65 percent of the fish were 18 years or older. Since male paddlefish do not usually mature until they are seven or eight years old and females until 10-12 years, we know that the population being harvested at Intake is comparatively young.

How does this information help us in our management of this particular species? First, we have to have some additional information on how and where the paddlefish lives. In short, what are his habitat requirements. Garrison Reservoir was finished and started filling in 1953. This large impoundment as it filled would probably have provided ideal habitat for the survival of young paddlefish.

Reservoirs, when they are new and filling, provide exceptionally large amounts of plankton, the microscopic plants and animals that are food of paddlefish. The filling of Garrison Reservoir and the formation of this large group of seven to 12 year old paddlefish correspond exactly. The aging information along with tagging data indicate quite strongly that the spawning runs of paddlefish at Intake are moving out of Garrison Reservoir and that the filling of Garrison Reservoir is responsible for this large group of fish.

It is a possibility that the 7-12 year old fish we are now catching at Intake will make up the majority of the fishery for years to come. If conditions in Garrison have changed so that survival and growth of young fish is reduced, this could well be the case. This would mean, then, that each year this group of fish would be getting older and consequently fewer in number until after 5 or 10 years they would probably fade out of the fishery entirely. This would mean that at the end of 5 or 10

years, or by the time this age group has died, that there would be a much reduced paddlefish population and consequently not much of a fishery.

It could also be that survival will continue to be good and that we could expect continued large runs of fish each spring. Only by continued checking on the population each year will we know if younger fish are entering the run. In any case, the management implications of this study show that the fishermen should continue to harvest a portion of these fish each year. If this group of fish (7-12 years old) is not fished, they will be lost anyway through natural mortality. There is no way we can stock pile populations of fish or game. On the other hand, if runs of younger fish come into the fishery each year, an increase in the fishing pressure or a larger limit would not endanger the paddlefish.

The study on these fish will continue. Each year a sample of the fish will be checked so we may determine the age structure of the population. Tagging of fish will continue in an attempt to learn more about their movements. An effort will also be made to get an estimate of the number of fish being taken each year. There are many questions regarding this interesting species that are still unanswered. Why there are so few females in the run at Intake is an important question that needs answering. Only through continued research can we ever hope to get answers to these questions that will enable us to better manage the fishery.

CONSERVATION STICKER GOES ON SALE

The seven dollar conservation sticker that made its debut in the spring of 1965 went on sale in March at several government offices, many AAA offices, and at entrance points to a number of federal recreation areas.

This entry ticket to federal recreation areas commonly known as a "recreation sticker" last season now bears the official title "Federal Recreation Area Entrance Permit." It's gold colored this year and made to fit a billfold rather than to be stuck on a bumper or windshield. The owner of a permit can use it for entry in lieu of other admission charges. It will admit the holder **only** when he is traveling on a commercial bus or other non-private vehicle. When the holder is traveling in his own car, the permit will admit him and all who accompany him to more than 7,000 federal recreation areas.

Areas covered by the annual $7.00 permit include those administered by the National Park Service, Bureau of Sports Fisheries and Wildlife, Bureau of Land Management, Bureau of Reclamation, Forest Service, Army Corps of Engineers, and Tennessee Valley Authority.

Money derived from the sale of the Federal Recreation Area Entrance Permit is used to match funds on a 50-50 basis for acquisition and development of outdoor recreation facilities on a state, county, and municipal basis.

New Animal Aging Technique Has Promise

Tooth replacement and wear is the most commonly used method of determining age in most species of big game at the present time. This method was perfected on deer and elk by the use of jaws from animals of known age.

Rather recently it was discovered that a layer of cementum is deposited each year on the roots of teeth of many species of animals. In 1952 R. M. Laws, who worked with seals, reported the use of these rings as an indicator of age. Subsequently, use of the technique was described for determining ages of moose, caribou, elk and deer by other investigators.

In general, the method consists of sectioning an incisor (front tooth) to reveal a cross-section of the cementum of the root. Various chemicals are used to treat the cementum and make the rings appear more distinct. Alcohol is most common, but hydrochloric acid and complete decalcification with formic acid has also been used. The tooth section is then examined under a microscope. Under optimum conditions, the layers appear similar to the annual rings of a tree. Each annual layer consists of a translucent zone and an opaque zone. The translucent area is laid down during the summer and the opaque during late winter. After the line between the dentine and the cementum is identified, either the translucent zones or the opaque zones may be counted in order to determine the age of the animal. Work with known age deer has shown this method to be quite accurate. A variation of the method using the 1st molar has also been developed for deer.

Although further research is needed before the method can be adopted for general use, it appears to have a promising future in the field of big game management. At the present time work is underway to adapt the technique for aging moose in southwest Montana. The lack of jaws and teeth from animals of known ages, however, is presently hampering the progress of this investigation.

Nine Years of Blue Grouse Banding —Some Conclusions

Spring of 1966 will mark the beginning of the tenth year of blue grouse banding studies in various areas of Montana. Since 1957, a total of 921 wild blues have been banded over central, southwestern and western parts of the state. Objectives of the banding programs have centered around the study of grouse habitats, habitat requirements and the relationship of hunting and land use to grouse.

Many hundreds of grouse taken by hunters have been checked for bands. Less than seven percent of the banded grouse are known to have been shot by hunters, and there is no evidence to indicate that hunting has been a limiting factor to grouse populations. The natural attrition, or mortality rate, of adult blue grouse has been 35-40 percent annually. Young grouse show a higher rate of loss. The percent of banded grouse returning to breeding areas after the hunting and winter seasons is checked each spring. Breeding stock on a popular Bitterroot grouse hunting area has remained relatively stable since 1962. General production has shown a gradual improvement since taking a nose dive in much of western Montana during 1963.

Banding studies have provided an improved scientific basis for gradually liberalizing mountain grouse hunting seasons during the past decade. Banding will continue as an important grouse research tool and as a safeguard in an era of increasing hunter numbers and easier access to mountain areas.

Spacious green meadows and groves at James Kipp State Park makes the park an excellent area for camping and picnicking. This is a popular spot for boaters to beach after having floated downriver through the picturesque Missouri River Waterway.

JAMES KIPP STATE PARK

On a hot August afternoon in 1959, thousands of people sat in the shade of tall cottonwoods along the Missouri River adjacent to the Fred Robinson Bridge to witness the dedication of James Kipp State Park. One hundred and twenty-eight years before, James Kipp—the man for whom the park was named—passed the same spot on his way up the river to open a rich, new fur country for the American Fur Company.

James Kipp was responsible for the opening of the fur trade in what is now north central Montana. In opening that trade he paved the way for the establishment of Fort Benton, the town that ultimately became the commercial nerve center of the Territory of Montana. James Kipp accomplished what no other white man had hitherto been able to do—he established peaceful relations with the powerful and warlike Piegan Division of the Blackfeet Indians. Also, in 1959, the State Highway Commission completed a new bridge across the Missouri River at this same location. The completion of this bridge had long been a dream of residents on both the north and south sides of the river. For many years the only means of crossing the river anywhere between Fort Benton and Fort Peck Dam were two or three ferries. The completion of the bridge, together with the link-up of highways from the north and south marked an historic point in north central Montana.

About the same time as the bridge was completed, the Parks Section completed negotiations with the U. S. Army Corps of Engineers for the leasing of four hundred acres of land adjacent to the bridge for State Park purposes. At the dedication of the new bridge in August of 1959, the State Park was also dedicated and a few facilities had been installed in time for the event. This State Park located approximately half way between Malta and Lewistown on U.S. 191, has been a veritable oasis for the traveler. It provides a tree shaded break for a noon picnic lunch or a pleasant interlude on a hot summer afternoon.

Fishermen have found the facilities and the location of James Kipp State Park ideal for their efforts in enticing the wily denizens of the Missouri. As a unique treat, the prehistoric paddlefish has been caught at this location and record catches have been established. It is an ideal location for campers and picknickers from communities to the north and to the south. Summer evenings find the area being used for pleasant family outings.

Another activity that has become popular in recent years is a boat trip from Fort Benton to the Park or on to Fort Peck Reservoir through the unspoiled Missouri River Breaks which, even today, are pretty much the same as when Lewis and Clark made their journey up-stream through Montana. Boating facilities at the Park make it possible to launch boats for pleasure trips on the Missouri or on the vast reaches of Fort Peck Reservoir.

Additional facilities for use by the public are planned for installation in the summer of 1966.

The Kipp name, older than Mon-

tana, is significant today. It is a name that belongs to the past; it is a name that commands respect in the present. As the new Fred Robinson Bridge opened a great part of north central Montana to increased traffic, it is fitting that this State Park, situated at that bridge, should be dedicated to James Kipp, the man who was most responsible for opening the whole area to white settlement.

Parks Submit Projects

A new look in the water-based state parks will soon be a reality. Development plans are being firmed up which will result in better parking areas, more boat ramps, improved water systems, better sanitary facilities, more picnic and camping units and a general rehabilitation of those state parks where motor boating is permitted.

How did all this come about? First of all there was legislation passed by the 1963 session of the Legislature which provided that 1% of the state gasoline tax would be placed in the state park fund to be used for development, maintenance and operations in those parks where motor boating is permitted. This same legislation was repeated by the 1965 Legislature when the administration of the Montana State Parks was transferred from the State Highway Department to the State Fish and Game Department.

On September 4, 1964, the Congress passed the Land and Water Conservation Fund Act. This act provides funds for the acquisition, planning and development of outdoor recreation areas on a 50-50 matching basis. This act is administered by the Bureau of Outdoor Recreation. This means that the State Parks Section of the Montana Fish and Game Department may plan, acquire lands if necessary and develop state parks, existing as well as proposed, with 50% state funds and 50% federal funds from the Land and Water Conservation Fund.

With funds that have been made available through the 1% gasoline tax, the State Parks Section has been able to develop plans and projects for all state parks that are water-based (i.e. state parks where motor boating is permitted). The Parks Section will get a good start on the long over-due development of these parks because of the provisions of the Land and Water Conservation Act and because of the funds made available by the 1% gasoline tax provisions. The result will be a program of developments in our water-based parks which are vitally needed and which has never before been experienced.

To carry out this program the Parks Section has submitted projects to the Bureau of Outdoor Recreation for approval. The projects were divided in seven segments to coincide with the seven administrative districts of the State Fish and Game Department. In District One the parks that are included in this project and the funds planned for improvements are:

Flathead Lake State Park	$57,475.00
West Shore State Park	24,300.00
Yellow Bay State Park	11,025.00
Bitterroot Lake State Park	11,300.00
Whitefish Lake State Park	17,800.00
Thompson Falls State Park	12,300.00
Finley Point State Park	18,875.00
Bigfork State Park	3,500.00

The total for District One amounts to $181,125.00 which includes $12,000.00 for possible acquisition of additional lands.

In District Two there is only one park included in this project. This is Painted Rocks Reservoir where a total of $19,300.00 has been budgeted.

In District Three the only project included is at the Missouri River Headwaters State Monument. The amount budgeted for the Headwaters amounts to $10,000.00.

In District Four the projects are:

Canyon Ferry Recreation Areas	$63,200.00
Tiber Reservoir Recreation Areas	28,250.00
James Kipp State Park	21,550.00

In District Five the only project is at Deadman's Basin Reservoir. The amount budgeted is $18,350.00.

In District Six there are two state parks included in the project. At Rock Creek State Park—$3,500.00 has been budgeted and at Nelson Reservoir Recreation Area $22,300.00 has been budgeted.

In District Seven—$8,300.00 has been programmed for Hell Creek State Park.

The total amount in all seven districts amounts to $375,925.00.

The projects in District Two, District Four and District Five have been approved by the Bureau of Outdoor Recreation and the work on these projects is expected to get under way by early summer. Approval of the projects in the other districts is expected later this spring.

It should be noted that these projects are all planned for the water-based parks. The reason is simply because the Parks Section has available funds for use in parks where motor boating is permitted from the source of the 1% gasoline tax.

No projects are planned for the land-based parks. These parks have to be operated by funds appropriated by the Legislature from the general fund. The funds made available during the current biennium are barely sufficient for minimum operations and maintenance. There are no funds for development which could be used to match money that is available in the Land and Water Conservation Fund. It is hoped that this situation can be remedied by the next session of the Legislature so that badly needed development in the land-based parks may be programmed.

Stream Preservation Administrative Report—1965

The original Stream Preservation Law enacted in 1963 was reviewed and given permanent status by the 1965 legislature. The passage of this bill gave stream preservation overwhelming approval. The new law differed from the old by changing the method for selecting a board of arbitration. More important, biennial legislative renewal is no longer required.

During the first 18 months under the old law, decisions were not reached on three projects. During 1965 satisfactory agreements were reached on two of these three projects. The controversial Rainbow Bend Project is the only one not yet resolved. Just recently negotiations were reopened with the Highway Department on this project.

During 1965, the Fish and Game Department received 53 legal notices of projects affecting fishing waters. The Fish and Game Commission asked for special consideration on 16 of these projects, roughly three of every 10. On certain projects the commission asked that some lengths of planned roadway be relocated to avoid irreplaceable damage to streams. On other projects requests were made for meanders to be built in order to replace those cut off from the natural stream. In still other situations requests were made

to build channels with pools and riffles in order to replace those eliminated through construction and replanting of brushy streambank vegetation was asked in order to replace some which had been destroyed. All requests were granted. It has not been necessary, therefore, to submit any project to arbitration.

Of the 53 legal notices of pending construction received and reviewed, 45 have come from the State Highway Department. The remaining eight were received from cities and counties.

It became clear that the Fish and Game Department was not being informed as required by law of highway **maintenance** projects affecting streams and measures were sought to correct this problem in 1965. The department obtained an additional written agreement with the State Highway Department maintenance section spelling out a workable procedure for reviewing this type of project. Since maintenance projects are initiated in a state highway district office, initial contact is made with the Fish and Game district office by district highway personnel.

Two important procedures were worked out with the preconstruction section of the State Highway Department. First, the Fish & Game is allowed to attend and participate in preliminary route inspections. These "P-Line" inspections are made before any costly design has been initiated or right-of-way purchased. At this time, line or route changes can be made with great facility. Secondly, a special provision was incorporated in construction methods used by all road contractors. It specifies that when channel changes or alterations are being undertaken the contractor will confine his work and equipment within staked limits of such construction. Removal of existing vegetation and ground cover will not be permitted adjacent to construction limits.

Ravalli county questioned whether or not it is legally necessary for counties to notify the Fish and Game Commission of projects around bridges because of a previous law. The Attorney General ruled that "the Stream Preservation Law does place upon the County Commissioners the additional obligation to notify the State Fish and Game Commission of any plans for construction of any projects." Since this ruling, the Commission has been notified of county projects throughout the state as a matter of routine.

Although the Bureau of Public Roads is not required to send a legal notice of construction to the Fish and Game Commission, they follow the intent of our Stream Preservation Law. This is important because the Bureau designs, locates and builds many miles of road each year on federal lands in Montana.

The Fish and Game Commission has signed a cooperative agreement with the Soil Conservation Service. It provides that the Fish and Game Department will be consulted on projects affecting streams prior to approval of Federal cost sharing under the Agricultural Conservation Program (ACP). By working with the SCS many miles of fish habitate can be saved through suggesting permanent and practical alternatives to projects which may otherwise be very detrimental to fishing streams.

The Fish and Game Department has also established liaison with the railroad companies in Montana. Although the department is not consulted on all projects it has been notified on some and recommendations on these projects have been incorporated into final plans.

The department has started to evaluate some of the habitat mitigation measures which construction agencies have undertaken on department recommendations in order to evaluate their effectiveness. This work is being done by fisheries personnel in the Fish and Game districts.

WINTERKILL OF FISH

Throughout the entire northern hemisphere, February and March, is the time of year when winterkill of fish in ice and snow-covered lakes occurs most often. "Why does this happen?" ask many people, "and why isn't something done about it?"

The truth of the matter is that winterkill is not a sudden happenstance. For the most part lakes susceptible to winterkill are a product of the geology of the area. Gigantic upthrusts of the Rocky Mountains provide protection from the wind to many a scenic lake. Snow accumulates, preventing the penetration of the light which green plants depend on for energy. Many fertile valleys are dotted with lakes filled with the rich, oxygen-sapping soils from the watershed. Man, who is not the puny force once supposed, has created many winterkill lakes by allowing the rich topsoil and organic debris to erode and wash into the lakes. This rich silt and organic matter forms an oxygen-sapping blanket on the bottom and a clouding of the water which lessens the penetration of light.

A lake does not become susceptible to winterkill suddenly. It is important to understand some of the complex physical and chemical factors involved. Most lakes somewhat protected from the wind form a layer of water in the summer which prevents the mixing of the top water with the bottom water. This point at which these two layers meet, is called a thermocline. Water changes with changes in temperature. It is heaviest at 40 degrees Fahrenheit and is lighter above and below that temperature. In the area of the thermocline the water temperature changes rapidly with change in depth. For instance, if the thermocline is between 20 and 30 feet, the temperature of the water at 25 feet will be one to two degrees colder than the water at 24 feet. Above and below this layer the change in temperature will be less than one degree per foot.

Imagine a plastic bag containing one cubic foot of water and this bag of water is on the bottom at a temperature of 40 degrees. To pull up this bag of 40 degree water to the surface, which has a temperature of 70 degrees, would require a force of about one tenth of a pound. Furthermore, as you pull it through the thermocline it would require a greater pull per foot of rise than it would above or below that layer. One tenth of a pound is not much, but let's say we wanted to raise a layer of water from the bottom having the dimensions of 660 feet long by 66 feet wide and one foot deep. This is only one acre foot in size, but it would require a force of nearly 2½ tons.

In most fertile lakes, the layer of water below the thermocline becomes devoid of oxygen by mid-summer. There are two basic reasons for this. The first is that this layer of water receives very little light penetration so no oxygen is produced. Secondly, the plants and animals produced above this layer die and fall into the bottom layer and their decay uses up the scanty stores of oxygen.

In the fall when the surface water cools to about 40 degrees, the entire lake water mixes, and the entire lake

Air pumped through hoses on the bottom of Brown's Lake near Ovando has opened a 400-foot gash in the lake ice.

is recharged with oxygen. If no thermocline is present in the summer because of the shallowness of the lake or the great amount of wind action, more of the decayable material has been broken down by the time of ice cover. There is a point reached on very shallow fertile lakes where the production of decayable material or the influx of material is too great for the meager stores of oxygen, consequently, these types of lakes may be devoid of oxygen most of the winter.

Under ice cover similar thermal barriers are established which prevent the mixing of the waters. Our plastic bag of water which is again at 40 degrees is going to remain on the bottom until the surface water is warmed to above 40 degrees in the spring. Because the amount of decayable material is greatest near the bottom, these waters become devoid of oxygen very soon, with no chance for interchange with the waters above.

Sunlight is the basic energy source that green plants, large and small, need to grow and produce oxygen to the water. The plants while growing or maintaining themselves take carbon dioxide from the water, use the sunlight for energy and produce simple plant sugars and the by-product given off is oxygen. As little as two inches of snow will decrease the amount of light penetration below that needed for optimum plant growth or well being. The snow may get so deep that virtually no light gets into the water and at this time the plants begin to die, adding their decaying stems and leaves to further demands on the oxygen supplies. Deep lakes not heavily fertilized from the surrounding watershed may s t o r e enough oxygen to carry through the winter.

Back to the question of why don't we do something about winterkill. In 1917 Dr. Henry B. Ward of the University of Illinois was asked whether chopping holes in the ice would prevent winterkill. He wrote, "In my opinion, the assistance afforded the oxygen supply by maintaining openings in the ice is so trifling as to be set aside without consideration." Dr. Ward knew at that time that the oxygen derived from the opening in the ice would replenish surrounding waters at a ridiculously slow rate. It has been calculated that to saturate Lake Constance in Switzerland with oxygen by diffusion alone would require about one million years.

The killing of fish through oxygen depletion is not confined to months of ice cover. In the more fertile lakes and ponds summer kills by oxygen depletion are quite common. Two or three cloudy calm days will cause oxygen depletion in weedy bays and algae laden pond waters. Fish kills of major proportions have resulted. The basic cause is the same as in the winter—poor light transmission and no mixing of the water by the wind.

Spreading of coal dust to melt snow is a technique that has been used off and on for forty or more years. It seems to work on small ponds when weather conditions are ideal. But distributional logistics on most lakes would be prohibitive with no guarantee that the weather would cooperate.

Air compressors have been and are being used to pump oxygen into the lakes. It theoretically serves two purposes. It pumps oxygen into the bottom waters and each bubble rising to the ice surface carries a film of warm (40 dagree) water with it. In time, this warm water melts the ice, creating an opening for light transmission. Summary of work done in Michigan is "There is a strong possibility that air induced circulation helped **cause** the winterkills instead of preventing them." In these cases, the waters from the lake bottom which were devoid of oxygen placed a drain on the top layers which were near borderline in oxygen already. In Minnesota air compressors have been used and it was found that the effects were too limited in area and amounts of oxygen produced. In Montana air compressors have been used on Brown's and Georgetown lakes in hopes of p r e v e n t i n g winterkill. Winterkill conditions have not developed since the air compressors were installed. However, the compressors are being used and measurements of temperatures near the air line and several hundred feet from the air line show that the circulation of water is limited to less than 100 feet from the air line. Improvements in oxygen content is likewise confined to within a hundred feet. Based on this, it can be concluded that should winterkill conditions develop on these lakes, the air compressors could do little to lessen the kill. Another potentially bad effect on small lakes would be the cooling of the water to a point where bottom insects and other food sources would be affected. Conceivably, if the lake were small enough and the weather cold enough, the lakes could be frozen to the bottom through the use of air compressors.

Plowing the snow from the lake or melting the snow by pumping water on the ice probably have the

greatest potential. However, keeping the ice snow-free would be a Herculean task on most lakes.

The most undesirable feature of winterkill is that the kill is rarely complete. The trout and most desirable game fishes are the first and often the only ones to die. Fish such as suckers, bullheads, carp and others can tolerate much lower oxygen levels than trout and survive in greater numbers. How much easier and successful the fish managers job would be of reestablishing game fish after winterkill if the competing trash fish were also dead.

The greatest potential lies in finding and using methods which would make the winterkill more severe. In other words, if we can't save the trout and other game fish, why not insure that nearly all of the fish will be killed. In some states, toxicants have been pumped under the ice after it is known that the game fish have succumbed. Most toxicants used to kill fish are of the type which prevent or reduce the ability of fish to breathe. Perhaps only small amounts of toxicant, if properly distributed, would be needed in lakes where the oxygen is low already.

The task of causing or worsening winterkill would not be easy. However, it is much easier to add to the forces causing oxygen depletion than to fight them. This our civilization is doing to lakes and streams every day with our agricultural, domestic and industrial pollution.

Sage grouse are now gathering on the mating grounds in force. Proud cocks spread their stiff tails into a virtual sunburst and strut through age-old rituals on ancestral grounds. The males also inflate large air sacks on either side of the neck, and then with a vibrant "plop" release the air. Hens generally have crept back to the expanses of sagebrush by early morning, but cocks more than likely continue to strut for some time after the sun has come up.

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